Claims

1. A monolithic, tandem photovoltaic (PV) cell comprising:

a compliant silicon substrate including a base silicon layer having a first PV subcell formed therein, a conductive perovskite layer, and a SiO_2 layer interposed between the conductive perovskite layer and the base silicon layer;

a second PV subcell positioned above the compliant silicon substrate; and

electrical contacts operably connected to the PV cell to conduct current to and from the PV cell.

2. A monolithic, tandem PV cell as defined in claim 1, wherein the conductive perovskite layer comprises electron doped strontium titanate.

3. A monolithic, tandem PV cell as defined in claim 1, wherein the conductive perovskite layer comprises strontium ruthenate.

4. A monolithic, tandem PV cell as defined in claim 1, wherein the conductive perovskite layer comprises $Sr_{1-x}La_xTiO_3$.

5. A monolithic, tandem PV cell as defined in claim 1, wherein the conductive perovskite layer comprises $SrTi_{1-x}Nb_xO_3$.

6. A monolithic, tandem PV cell as defined in claim 1, wherein the conductive perovskite layer comprises $SrTiO_{3-\delta}$., where $0< \delta <0.3$.

7. A monolithic, tandem PV cell as defined in claim 1, wherein the second PV subcell is formed of a group III-V direct band-gap semiconductor material.

8. A monolithic, tandem PV cell as defined in claim 7, wherein the group III-V direct band-gap semiconductor material comprises $GaAs_xP_{1-x}$.

9. A monolithic, tandem PV cell as defined in claim 7, wherein the group III-V direct band-gap semiconductor material comprises $Ga_xIn_{1-x}P$.

10. A monolithic, tandem PV cell as defined in claim 7, wherein the group III-V direct band-gap semiconductor material comprises GaAs.

11. A monolithic, tandem PV cell as defined in claim 1, wherein the conductive perovskite layer comprises electron doped strontium titanate and the second PV subcell is formed of a group III-V direct band-gap semiconductor material.

12. A monolithic, tandem PV cell as defined in claim 1, wherein the conductive perovskite layer comprises strontium ruthenate and the second PV subcell is formed of a group III-V direct band-gap semiconductor material.

13. A monolithic, tandem PV cell as defined in claim 1, further comprising an electrically conductive interconnection layer interposed between the compliant silicon substrate and the second subcell.

14. A monolithic, tandem PV cell as defined in claim 13, further comprising a back surface reflector (BSR) layer interposed between the interconnection layer and the second subcell.

15. A monolithic, tandem PV cell as defined in claim 14, wherein the BSR layer is formed of a material selected from a group consisting of $Ga_xIn_{1-x}P$, $Al_xIn_{1-x}P$, and $Al_xGa_yIn_{1-x-y}P$.

16. A monolithic, tandem PV cell as defined in claim 15, wherein the BSR layer has a thickness of between 0.01μm and 0.1μm.

17. A monolithic, tandem PV cell as defined in claim 1, wherein the conductive perovskite layer has a thickness of 30 Å to 300 Å.

18. A monolithic, tandem PV cell as defined in claim 17, wherein the SiO_2 layer has a thickness of between 5 Å and 12 Å.

19. A monolithic, tandem PV cell as defined in claim 18, wherein the base silicon layer has a thickness of between 50 to 150 μm.

20. A multi-junction, monolithic, photovoltaic (PV) cell configured for producing a photocurrent when exposed to photons, comprising:

a compliant substrate including a base layer having a first PV subcell formed therein, a conductive perovskite layer, and an oxide layer interposed between the conductive perovskite layer and the base layer;

a second PV subcell monolithically formed above the compliant silicon substrate;

an electrically conductive interconnection layer interposed between the compliant substrate and the second PV subcell; and

electrical contacts operably connected to the PV cell to conduct current to and from the PV cell.

21. A multi-junction, monolithic, PV cell as defined in claim 20, wherein the base layer is formed of monocrystalline silicon.

22. A multi-junction, monolithic, PV cell as defined in claim 21, wherein the oxide layer is formed of SiO_2.

23. A multi-junction, monolithic, PV cell as defined in claim 20, wherein the conductive perovskite layer comprises electron doped strontium titanate.

24. A multi-junction, monolithic, PV cell as defined in claim 20, wherein the conductive perovskite layer comprises $Sr_{1-x}La_xTiO_3$.

25. A multi-junction, monolithic, PV cell as defined in claim 20, wherein the conductive perovskite layer comprises $SrTi_{1-x}Nb_xO_3$.

26. A multi-junction, monolithic, PV cell as defined in claim 20, wherein the conductive perovskite layer comprises $SrTiO_{3-\delta}$.

27. A multi-junction, monolithic, PV cell as defined in claim 20, wherein the second PV subcell is fabricated from a group III-V direct band-gap semiconductor material.

28. A multi-junction, monolithic, PV cell as defined in claim 27, wherein the group III-V direct band-gap semiconductor material comprises $GaAs_xP_{1-x}$.

29. A multi-junction, monolithic, PV cell as defined in claim 27, wherein the group III-V direct band-gap semiconductor material comprises $Ga_xIn_{1-x}P$.

30. A multi-junction, monolithic, PV cell as defined in claim 27, wherein the group III-V direct band-gap semiconductor material comprises GaAs.

31. A multi-PV subcell, monolithic, photovoltaic (PV) cell configured for producing a photocurrent when exposed to photons, comprising:

a compliant silicon substrate including a base silicon layer having a first PV subcell formed therein, a conductive perovskite layer, and an oxide layer interposed between the conductive perovskite layer and the base silicon layer;

a second PV subcell formed of a group III-V direct band-gap semiconductor material; and a third PV subcell formed of a group III-V direct band-gap semiconductor material.

32. A multi-PV subcell, monolithic, PV cell as defined in claim 31, wherein the third PV subcell is formed of $Ga_xIn_{1-x}P$.

33. A multi-PV subcell, monolithic, PV cell as defined in claim 32, wherein the second PV subcell is formed of $GaAs_xP_{1-x}$.

34. A multi-PV subcell, monolithic, PV cell as defined in claim 32, wherein the second PV subcell is formed of GaAs.

35. A multi-PV subcell, monolithic, PV cell as defined in claim 31, further comprising a first electrically conductive interconnection layer interposed between the compliant silicon substrate and the second PV subcell and a second electrically conductive interconnection layer interposed between the second PV subcell and the third PV cell.

36. A multi-PV subcell, monolithic, PV cell as defined in claim 35, further comprising a first back surface reflector layer interposed between the first electrically conductive interconnection layer and the second PV subcell.

37. A multi-PV subcell, monolithic, PV cell as defined in claim 36, further comprising a second back surface reflector layer interposed between the second electrically conductive interconnection layer and the third PV subcell.

38. A multi-PV subcell, monolithic, PV cell as defined in claim 36, wherein the first electrically conductive interconnection layer and the second electrically conductive interconnection layer comprise tunnel junctions.

39. A multi-PV subcell, monolithic, PV cell as defined in claim 31, wherein the conductive perovskite layer comprises electron doped strontium titanate.

40. A multi-PV subcell, monolithic, PV cell as defined in claim 39, wherein the conductive perovskite layer comprises $Sr_{1-x}La_xTiO_3$.

41. A multi-PV subcell, monolithic, PV cell as defined in claim 39, wherein the conductive perovskite layer comprises $SrTi_{1-x}Nb_xO_3$.

42. A multi-PV subcell, monolithic, PV cell as defined in claim 31, wherein the conductive perovskite layer comprises $SrTiO_{3-\delta}$.

43. A multi-PV subcell, monolithic, PV cell as defined in claim 31, wherein the conductive perovskite layer comprises strontium ruthenate.

44. A method of forming a multi-junction, monolithic, photovoltaic (PV) cell, comprising:
forming n-type and p-type regions in a base silicon layer to create a first PV subcell within the base silicon layer;

forming a conductive perovskite layer above the base silicon layer;

forming an oxide layer between the conductive perovskite layer and the base silicon layer; and

forming a second PV subcell of a group III-V direct band-gap semiconductor material above the conductive perovskite layer.

45. A method of forming a multi-junction, monolithic, PV cell as defined in claim 44, further comprising forming a third PV subcell of a group III-V direct band-gap semiconductor material above the second PV subcell.

46. A method of forming a multi-junction, monolithic, PV cell as defined in claim 44, further comprising forming a first electrically conductive interconnection layer between the conductive perovskite layer and the second PV subcell.

47. A method of forming a multi-junction, monolithic, PV cell as defined in claim 46, further comprising forming a first back surface reflector layer between the first electrically conductive interconnection layer and the second PV subcell.

48. A method of forming a multi-junction, monolithic, PV cell as defined in claim 45, further comprising forming a first electrically conductive interconnection layer between the conductive perovskite layer and the second PV subcell and a second electrically conductive interconnection layer between the second PV subcell and the third PV subcell.

49. A method of forming a multi-junction, monolithic, PV cell as defined in claim 48, further comprising forming a first back surface reflector (BSR) layer between the first electrically conductive interconnection layer and the second PV subcell, forming a second BSR layer between the second PV subcell and the second electrically conductive interconnection layer, and forming a third BSR layer between the second electrically conductive interconnection layer and the third PV subcell.

50. A method of forming a multi-junction, monolithic, PV cell as defined in claim 49, further comprising forming a window layer above the third PV subcell.

51. A method of forming a multi-junction, monolithic, PV cell as defined in claim 44, wherein the conductive perovskite layer is formed of $Sr_{1-x}La_xTiO_3$.

52. A method of forming a multi-junction, monolithic, PV cell as defined in claim 44, wherein the conductive perovskite layer is formed of $SrTi_{1-x}Nb_xO_3$.

53. A method of forming a multi-junction, monolithic, PV cell as defined in claim 44, wherein the conductive perovskite layer is formed of $SrTiO_{3-\delta}$.

54. A method of forming a multi-junction, monolithic, PV cell as defined in claim 44, wherein the conductive perovskite layer is formed of strontium ruthenate.

55. A method of forming a multi-junction, monolithic, PV cell as defined in claim 44, wherein the second PV subcell is formed of $GaAs_xP_{1-x}$.

56. A method of forming a multi-junction, monolithic, PV cell as defined in claim 44, wherein the second PV subcell is formed of $Ga_xIn_{1-x}P$.

57. A method of forming a multi-junction, monolithic, PV cell as defined in claim 44, wherein the second PV subcell is formed of GaAs.

58. A method of forming a multi-junction, monolithic, PV cell as defined in claim 45, wherein the third PV subcell is formed of $Ga_xIn_{1-x}P$.

59. A method of forming a multi-junction, monolithic, PV cell as defined in claim 58, wherein the second PV subcell is formed of GaAs.

60. A method of forming a multi-junction, monolithic, PV cell as defined in claim 58, wherein the second PV subcell is formed of $GaAs_xP_{1-x}$.

61. A monolithic, tandem photovoltaic (PV) cell comprising:

a compliant silicon substrate including a base silicon layer having a first PV subcell formed therein, a perovskite layer, and a SiO_2 layer having a thickness of between 5 Å and 12 Å interposed between the conductive perovskite layer and the base silicon layer;

a second PV subcell positioned above the compliant silicon substrate; and

electrical contacts operably connected to the PV cell to conduct current to and from the PV cell.

62. A multi-PV subcell, monolithic, PV cell as defined in claim 61, wherein the perovskite layer is between 30 Å and 300 Å.

63. A multi-PV subcell, monolithic, PV cell as defined in claim 62, wherein the perovskite layer comprises strontium titanate.